

which continually regenerate themselves and grow through polymerization” (Pflüger, 1875, p. 343, as quoted in Fruton, 1972, p. 284).

As Pflüger’s proposal exemplifies, theorizing about metabolic mechanisms in the later part of the nineteenth century was highly speculative. In large part, this was because proteins are extremely complex and it was not possible at the time to establish that they were even molecular in character. Whereas organic chemists focused on relatively simple molecules in order to make progress in articulating the structure of organic compounds, researchers interested in the chemistry underlying physiological functions emphasized the likely importance of complex organization. One avenue toward complexity was offered by colloid chemistry, which emphasized molecules organized in arrays on surfaces. It became increasingly influential after Thomas Graham (1861) proposed that protoplasm was composed of colloidal arrays rather than less structured molecules. Investigators such as Wolfgang Ostwald (1909) emphasized the multiple phases of colloidal dispersion and the energies associated with surfaces. Some historians of biochemistry, such as Marcel Florkin (1972, pp. 279–83), have bemoaned this as the “dark age of biocolloidology.” Florkin portrayed the influence of colloid chemistry on physiology as hindering the advance of a theoretically sound biochemistry and so drew a sharp contrast between colloidal chemistry and biochemistry. Yet, even as major a contributor to biochemistry as Otto Warburg began his career emphasizing the importance of colloidal surfaces for cell respiration (Warburg, 1911; Warburg, 1913b).²⁹

The Emergence of Biochemistry in the Twentieth Century

The pioneering efforts to provide chemical explanations of vital processes in the nineteenth century suddenly developed into a robust research endeavor in the early twentieth century. At this time, the term *biochemistry* began to supplant older labels such as *physiological chemistry*. In the first decade of the twentieth century, new journals developed with *biochemistry* in their titles³⁰ and new professional societies were established.³¹ In 1909 Carl Oppenheimer

²⁹ Warburg was generally dismissive of the emphasis on enzymes in mainstream biochemistry and pointedly referred to them using an older term, *ferment*. He identified one such important substance himself, which he called *Atmungsferment* (now known as cytochrome oxidase).

³⁰ In 1902 *Biochemisches Centralblatt, vollständiges Sammelorgan für die Grenzgebiet der Medizin und Chemie*; in 1903 *Beiträge zur chemischen Physiologie und Pathologie, Zeitschrift für die gesamte Biochemie*; in 1905 *Journal of Biological Chemistry*; in 1906 both the *Biochemical Journal* and *Biochemische Zeitschrift*.

³¹ In 1905 the American Chemical Society initiated a section of biological chemistry and in 1911 in England the Biochemical Club – later to become the Biochemical Society – was founded.